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<b>(21) International Application Number:</b> PCT/US90/06395 <b>(22) International Filing Date:</b> 5 November 1990 (05.11.90)  <b>(30) Priority data:</b> 440,224 22 November 1989 (22.11.89) US  <b>(71)(72) Applicant and Inventor:</b> GUNNERMAN, Rudolf, W. [US/US]; 4100 Folsom Boulevard, 9D, Sacramento, CA 95814 (US).  <b>(74) Agent:</b> KUSTIN, Carl; Christie, Parker & Hale, P.O. Box 7068, Pasadena, CA 91109-7068 (US).  <b>(81) Designated States:</b> AT (European patent), AU, BE (Euro- pean patent), BR, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FI, FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, KR, LU (European patent), NL (European patent), NO, SE, SE (European patent), SU.		<b>Published</b> <i>With international search report.</i> <i>With amended claims.</i>
<b>(54) Title:</b> AQUEOUS FUEL FOR INTERNAL COMBUSTION ENGINE AND METHOD OF COMBUSTION  <b>(57) Abstract</b>  A novel aqueous fuel for an internal combustion engine is provided. The fuel comprises water from about 20 per cent to about 60 per cent by volume of the total volume of said fuel, and a carbonaceous fuel selected from the class consisting of ethanol, methanol, gasoline, diesel fuel or mixtures thereof. A novel method for combusting an aqueous fuel in an internal combustion engine is provided. The method produces approximately as much power as the same volume of gasoline. The method comprises introducing preheated air and said aqueous fuel into a carburetor or fuel injection system, said fuel comprising water from about 20 per cent to about 60 per cent by volume of the total volume of said fuel, and a carbonaceous fuel selected from the group consisting of ethanol, methanol, gasoline, diesel fuel or mixtures thereof, and introducing and combusting said air/fuel mixture in a combustion chamber or chambers in the presence of a hydrogen producing catalyst to operate said engine.		

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10           **AQUEOUS FUEL FOR INTERNAL COMBUSTION ENGINE  
              AND METHOD OF COMBUSTION**

**Field of the Invention**

15           This invention relates to a novel aqueous fuel for  
an internal combustion engine and to a novel method of  
combusting such fuel in an internal combustion engine.

**Background of the Invention**

20           There is a need for new fuels to replace gasoline  
for use in internal combustion engines. Internal  
combustion engines operating on gasoline and diesel fuel  
produce unacceptably high amounts of pollutants which are  
injurious to human health and may damage the earth's  
atmosphere. The adverse effects of such pollutants upon  
25           health and the atmosphere have been subject of great  
public discussion and will not be belabored any further.

**Summary of the Invention**

30           A novel fuel and novel method of combustion have been  
discovered which will reduce pollutants produced by  
internal combustion engines operated on gasoline. This  
fuel is also much less expensive than gasoline or diesel  
fuel because its primary ingredient is water.

35           The novel fuel of the present invention has about  
1/3 the potential energy (BTU's) of gasoline, but when  
used to operate an internal combustion engine, it will  
produce approximately as much power as compared with the

1 same amount of gasoline. This is indeed surprising and  
is believed to be due to the release and combustion of  
hydrogen and oxygen when the novel fuel is combusted by  
the novel method of the present invention.

5 In its broadest aspects, the aqueous fuel of the  
present invention comprises substantial amounts of water  
of up to about 50 to about 60 percent by volume of the  
total volume of fuel, and a carbonaceous fuel selected  
10 from the group consisting of gasoline, ethanol, methanol,  
diesel fuel, or mixtures thereof. In utilizing this fuel  
with the novel method of the present invention, combustion  
air is preheated and introduced into the engine's  
carburetor or fuel injection system for mixing with the  
aqueous fuel. When using an engine with a carburetor,  
15 the combustion air is preheated to at least about 350°F  
to about 400°F as it enters the carburetor. When using  
an engine with a fuel injection system, the combustion air  
is preheated from about 122°F to about 158°F as it enters  
the fuel injection system. The air/fuel mixture is then  
20 introduced into the combustion chamber or chambers and  
combusted in the presence of a hydrogen producing catalyst  
to operate the engine.

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1     Detailed Description of the Preferred Embodiment

          The aqueous fuel of the present invention comprises water from about 20 percent to about 50 to 60 percent by volume of the total volume of the fuel and a carbonaceous  
5     fuel selected from the class consisting of ethanol, methanol, gasoline, diesel fuel or mixtures thereof. Ethanol and methanol generally contain small percentages of water when produced commercially. Commercial grades  
10    of ethanol and methanol are marketed in terms of a proof number, such as for example, 100 proof ethanol. One half the proof number is generally an indication of the amount of ethanol present, i.e., 100 proof ethanol contains 50 percent ethyl alcohol and 50 percent water; 180 proof ethanol contains 90 percent of ethyl alcohol and 10  
15    percent of water, etc.

          The aqueous fuel of the present invention is usable in conventional gasoline or diesel powered internal combustion engines for use in automobiles, trucks and the like, using conventional carburetors or fuel injection  
20    systems. The only modification necessary to such engines to make them usable with the fuel of the present invention is the installation of a hydrogen producing catalyst in the combustion chamber or chambers of the engine, the installation of a heater to preheat the combustion air for  
25    the engine, and the installation of a heat exchanger to use the hot exhaust gases from the engine to preheat the combustion air after the engine is operating, at which time the heater is shut off.

          In practicing the method of the present invention, combustion air for the engine is preheated before it is introduced into the carburetor or fuel injection system. When using an engine with a carburetor, the combustion air is preheated to at least about 350°F to about 400°F as it enters the carburetor. When using an engine with a fuel  
30    injection system, the combustion air is preheated from about 122°F to about 158°F as it enters the fuel  
35    injection system. The aqueous fuel of the present

1 invention is also introduced into the carburetor or fuel  
injection system and is mixed with the combustion air.  
The aqueous fuel may be preheated but is preferably  
5 introduced into the carburetor or fuel injection system  
at ambient temperatures. The air/fuel mixture is then  
introduced into the combustion chamber or chambers where  
a spark from a spark plug ignites the air/fuel mixture in  
the conventional manner when the piston of the combustion  
10 chamber reaches the combustion stage of the combustion  
cycle. The presence of a hydrogen producing catalyst in  
the combustion chamber and preheated condition of the  
combustion chamber is believed to liberate hydrogen and/or  
oxygen from the water in the aqueous fuel when the spark  
15 plug ignites the air/fuel mixture. The hydrogen and  
oxygen are also ignited during combustion to increase the  
amount of energy delivered by the fuel. Thus, it was  
observed in experiments using 100 proof alcohol as the  
engine fuel that the engine produced the same amounts of  
20 watts per hour as compared with the same amount of  
gasoline. This is indeed surprising in view of the fact  
that the 100 proof ethanol has about 48,000 BTU's per  
gallon as compared to gasoline, which has about 123,000  
BTU's per gallon, nearly three times as much. The fact  
25 that the lower BTU ethanol is able to generate as much  
power as a higher BTU gasoline suggests that additional  
power must be attributable to the liberation and  
combustion of hydrogen and/or oxygen from the water.

Inasmuch as 100 proof ethanol has been found to be  
a satisfactory fuel in using the method of the present  
30 invention, it is apparent that other suitable fuels may  
be made by blending ethanol and/or methanol with gasoline  
or diesel fuel depending on whether the fuel is to be used  
in a gasoline or diesel powered engine. Experimental work  
also indicates that 84 proof (58 percent water) ethanol  
35 may also be used as a fuel and it is believed that aqueous  
fuels containing as much as 70 percent water may be used.

1                    The Engine with Carburetor

To demonstrate the present invention, an engine was selected which also had the capacity to measure a predetermined workload. The engine selected was a one-cylinder, eight horsepower internal combustion engine connected to a 4,000 watt per hour a/c generator. The engine/generator was manufactured by the Generac Corporation of Waukesha, Wisconsin under the tradename Generac, Model No. 8905-0(S4002). The engine/generator is rated to have a maximum continuous a/c power capacity of 4,000 watts (4.0 KW) single phase.

The engine specifications are as follows:

Engine Manufacturer - Tecumseh

15            Manufacturer's Model No. - HM80 (Type 155305-H)

Rated Horsepower - 8 at 3600 rpm

Displacement - 19.4 cubic inches (318.3 cc)

20            Cylinder Block Material - Aluminum with cast iron sleeve

Type of Governor - Mechanical, Fixed Speed

25            Governed Speed Setting - 3720 rpm at No-Load (Rated a/c frequency and voltage (120/240 volts at 62 hertz) are obtained at 3600 rpm. The no-load setting of 3720 rpm provides 124/248 volts at 62 hertz. A slightly high no-load setting helps ensure that engine speed, voltage and frequency do not drop excessively under heavier electrical loading.)

Type of Air Cleaner - Pleated Paper Element

Type of Starter - Manual, Recoil Rope

30            Exhaust Muffler - Spark Arrestor Type

Ignition System - Solid State with Flywheel Magneto

Spark Plug - Champion RJ-17LM (or equivalent)

35            Set Spark Plug Gap to - 0.030 inch (0.76mm)

Spark Plug Torque - 15 foot-pounds

Crankcase Oil Capacity - 1-1/2 pints (24 ounces)

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Recommended Oil - Use oil classified "For Service  
SC, SD or SE"

5

Primary Recommended Oil - SE 10W-30 Multiple  
Viscosity Oil  
Acceptable Substitute - SAE 30 Oil

Fuel Tank Capacity - 1 gallon

Recommended Fuel -

10

Primary - Clean, Fresh UNLEADED Gasoline  
Acceptable Substitute - Clean, Fresh, Leaded  
REGULAR Gasoline

15

A heat exchanger was installed on the engine to use  
the hot exhaust gases from the engine to preheat the air  
for combustion. A platinum bar was installed to the  
bottom surface of the engine head forming the top of the  
combustion chamber. The platinum bar weighed one ounce  
and measured 2-5/16 inches in length, 3/4 inches in width,  
and 1/16 inch in thickness. The platinum plate was  
secured to the inside of the head with three stainless  
steel screws.

20

A second fuel tank having a capacity of two liters  
was secured to the existing one-liter fuel tank. A  
T-coupling was inserted into the existing fuel line of  
the motor for communication with the fuel line for each  
fuel tank. A valve was inserted between the T-coupling  
and the fuel lines for each fuel tank so that either tank  
could be used separately to feed fuel to the carburetor  
or to mix fuels in the fuel line leading to the  
carburetor.

30

#### Test Runs

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A series of tests were performed to determine if 100  
proof ethanol could be used in the motor which was  
modified as described above, and if so, to compare the  
performance of the 100 proof ethanol with the same amount  
of gasoline.



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1           Two liters of unleaded gasoline were poured into the  
second fuel tank with the valve for the second tank in the  
closed position. Three and eight tenths liters of 100  
proof ethanol were poured into the one gallon fuel tank  
5           with the valve in the closed position. The valve for the  
gasoline tank was opened so that the engine could be  
initially started on gasoline.

          Within three minutes of starting the motor, the  
combustion air entering into the carburetor was measured  
10          at 180°F. At this point, the fuel valve under the ethanol  
tank was opened and the valve under the gasoline tank was  
closed. At that point, the temperature of the air  
entering the carburetor had risen to 200°F.

          Ethanol was now the primary fuel in the motor which  
15          exhibited a certain amount of roughness during operation  
until the choke mechanism was adjusted by reducing the  
air intake to the engine by approximately 90 percent.  
Immediately thereafter, two, 1800 watt, heat guns, having  
a rated heat output of 400°F, were actuated and used to  
20          heat the combustion air as it entered the carburetor. The  
temperature of the air from the heat guns measured 390°  
to 395°F.

          After the engine ran on ethanol for approximately 20  
minutes, the heat measurement in the incoming combustion  
25          air stabilized between 347°F and 352°F. The engine was  
run on the 100 proof ethanol fuel for 40 additional  
minutes, for a total of one hour, until two liters of  
ethanol had been used. The valve under the ethanol tank  
was then closed and the engine was turned off by opening  
30          the choke. Eighteen hundred milliliters of ethanol were  
left remaining in the tank.

          The choke was then reset to the 90 per cent closed  
position, and the engine was started once again. The  
engine responded immediately and ran as smoothly on 100  
35          proof ethanol as it did during the one-hour operation.

1           The engine was stopped and started in the same manner  
on three separate occasions thereafter with the same  
results.

5           While operating the engine on 100 proof ethanol, the  
power output on the generator was measured and indicated  
that the ethanol produced 36,000 watts during a one-hour  
period using two liters of ethanol having 48,000 BTUs per  
gallon.

10          After the engine had stopped running on ethanol, it  
was operated again with the two liters of gasoline in the  
gasoline tank. 47 minutes into the test, the engine  
stopped because it ran out of gasoline. Measurements  
taken on the generator indicated that, when the engine  
was operated on gasoline, it was producing power at a rate  
15 of 36,000 watts per hour for 47 minutes, using two liters  
of gasoline having 123,000 BTUs per gallon.

20          Comparing these power measurements indicates that  
two liters of 100 proof ethanol produces the same amount  
of power as two liters of gasoline. This is surprising  
inasmuch as the gasoline has about 2.5 times as many BTUs  
as the same amount of 100 proof ethanol. This indicates  
that the extra power from the ethanol must be due to the  
liberation and combustion of hydrogen and/or oxygen from  
the relatively large amounts of water in the fuel.

25          Although gasoline was used as the starter fuel to  
preheat the engine and, thus, generate hot exhaust gases  
to preheat the combustion air, the use of the gasoline as  
the starter fuel is not necessary and could be replaced  
with an electrical heat pump to preheat the combustion air  
30 until the heat exchanger could take over and preheat the  
combustion air, whereupon the electrical heat pump would  
turn off.

35          The above tests comparing the use of the 100 proof  
ethanol and gasoline were repeated on three subsequent  
occasions, each with the same results.

A second series of tests were run which were  
identical to the above, except for the use of 84 proof

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1 ethanol (42 per cent ethyl alcohol and 58 per cent water)  
in place of the 100 proof ethanol. However, after running  
about 30 seconds on the 84 proof ethanol, the engine  
stopped abruptly and released a fair amount of oil under  
5 high pressure from the main bearing in the main engine.  
The engine was restarted and abruptly stopped again after  
operating for about 20 seconds.

The above stoppage appears to have been due to  
preignition of the hydrogen and/or oxygen during the up-  
10 stroke period of the piston which caused pressure build-  
up in the crank case, which in turn forced oil under  
pressure through the main bearing. The pressure inside  
the combustion chamber appears to have been relieved  
through the piston rings into the crank case, and then  
15 relieved through the main bearing.

The premature ignition of the hydrogen and/or oxygen  
was probably caused by generating a larger amount of  
oxygen and hydrogen which did not occur when using 100  
proof ethanol having a lesser amount of water.

20 The preignition problem can probably be cured by  
using an engine having a shorter piston stroke to reduce  
the dwell time of the fuel, including hydrogen and oxygen,  
in the combustion chamber, or by adjusting the carburetor  
or the electronically controlled fuel injection system to  
25 help reducing dwell time to avoid generating excessive  
amount of hydrogen and oxygen. The engine used in the  
experiment had a relatively long piston stroke of 6  
inches. The piston stroke should be no more than about  
1 1/2 inches or less to avoid the preignition problem in  
30 that particular engine.

#### ENGINE WITH ELECTRONICALLY CONTROLLED FUEL INJECTION SYSTEM

A series of tests were run on an engine having an  
electronically controlled fuel injection system to  
35 determine if that would solve the preignition problem  
discussed above. The engine used for this purpose was a  
3-cylinder turbo charge electronically controlled internal

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1 combustion engine from a 1987 Chevrolet Sprint which had  
been driven about 37,000 miles.

5 The head from the motor block was removed and cleaned  
to remove carbon deposits. Three platinum plates were  
attached to the inside of each head so as not to interfere  
with valves moving inside the heads during operation.  
Each platinum plate was 1 centimeter in length and width  
and was 1/32 of an inch in thickness. Each platinum plate  
was attached to the head with one stainless steel screw  
10 through the center of each piece. Carbon deposits were  
cleaned off each piston head and the engine was  
reassembled using new gaskets.

The combustion air intake hose which exits from the  
turbo and leads to the injector module is divided in the  
15 middle and attached to a heat exchanger to cool the  
combustion air delivered to the injector. The heat  
exchanger was bypassed by using two Y junctions on either  
side of the heat exchanger and by putting a butterfly  
valve on the side closest to the turbo so that the hot air  
20 stream could be diverted around the heat exchanger and  
introduced directly into the injector module. All  
pollution abatement equipment was removed from the engine  
but the alternator was kept in place. The transmission  
was reattached to the engine because the starter mount is  
25 attached to the transmission. The transmission was not  
used during the testing. This engine was inserted into  
a Chevrolet Sprint car having a tailpipe and muffler  
system which was necessary for the engine to run properly.  
The catalytic converter was left in the exhaust train but  
30 the inside of the converter was removed as it was not  
needed. Two one gallon plastic fuel tanks were hooked up  
to the fuel pump by a T-section having manual valves so  
the fuel to the fuel pumped could be quickly changed by  
opening or closing the valves.

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TEST RUNS

1 A series of test runs were performed to determine how the engine as modified above would run using a variety of fuels.

5 The first test utilized 200 proof methanol as a starter fluid. The engine started and operated when the fuel pressure was raised to 60 to 75 lbs. When using gasoline, the fuel pressure is generally set at 3.5 to 5 lbs.

10 While the engine was running on the 200 proof methanol, the fuel was changed to 100 proof denatured ethanol and the motor continued operating smoothly at 3500 revolutions per minute (rpm). After about two minutes the test was stopped and the engine shut down because the fuel  
15 hoses were bulging and became unsafe. These hoses were replaced with high pressure hoses and the plastic couplings and the T's were also replaced with copper couplings and T's. A new pressure gage was attached. During the testing, it was noted that the fuel mixture  
20 need more combustion air and that the computerized settings of the engine could not be adjusted to provide the additional air. To overcome this, the air intake valve was opened.

After these modifications, a new series of tests were  
25 performed using 200 proof methanol in one of two fuel tanks. The engine started on the 200 proof methanol and the rpm setting was adjusted to 3500. The engine was allowed to run for a few minutes. During that time, the fuel pressure was adjusted and it was noted that 65 lbs.  
30 of pressure appeared to be adequate. A thermocouple was inserted close to the injector module and provided a reading of 65°C after about 5 minutes.

A fuel mixture comprising 500 ml of distilled water and 500 ml of 200 proof methanol were put into the second  
35 fuel tank and was used to operate the engine. Without changing the air flow, the temperature of the combustion air rose from 65 to 75°C after about 1 minute. The rpm

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1 reading dropped to 3100 rpm. The engine ran very smoothly  
and was turned off and restarted without difficulty.

5 The next step in the test series was to determine how  
variations in the water content of the fuel effected  
engine performance. Using 199 proof denatured ethanol as  
starter fuel, the engine started immediately. The fuel  
pressure setting was reduced from 65 lbs. to 50 lbs, the  
combustion air measured 65°C, the rpm's measured 3500, and  
the engine ran smoothly.

10 The fuel was then changed into 160 proof denatured  
ethanol. The fuel pressure was maintained at 50 lbs. The  
combustion air temperature was measured at 67°C, the rpm's  
decreased to 3300, and the engine ran smoothly.

15 After 10 minutes, the fuel was changed to 140 proof  
denatured ethanol. The combustion air temperature rose  
to 70°C, the rpm's rose to 3500, and the engine ran  
smoothly.

20 After 10 minutes, the fuel was changed to 120 proof  
denatured ethanol. The combustion air temperature  
increased to 73°C, the rpm's decreased to 3300, and the  
engine ran smoothly.

25 After 10 minutes, the fuel was changed to 100 proof  
denatured ethanol. The combustion air temperature  
increased to 74°C, the rpm's decreased to 3100, and the  
engine ran smoothly.

After 10 minutes, the fuel was changed to 90 proof  
denatured ethanol. The combustion air temperature  
remained at 74°C, the rpm's reduced to 3100, and the  
engine ran smoothly.

30 After 10 minutes, the fuel was changed to 80 proof  
denatured ethanol. The combustion air temperature raised  
to 76°C and the rpm's reduced to 2900. At that point,  
an infrequent backfire was noted in the engine. 100 proof  
denatured ethanol was then used as the primary fuel and  
35 the bypass to the heat exchanger was closed. The  
combustion air temperature rose to 160°C and during the

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1 next minutes increased to 170°C. The rpm's increased to  
4000 rpm and the engine ran smoothly.

Another series of tests were run with the engine  
adjusted to operate at 3500 rpm's and with the heat  
5 exchanger removed. The engine was started with 200 proof  
ethanol as the fuel and as soon as the intake air  
temperature at the injector module had risen to about  
50°C, the fuel was changed to 100 proof ethanol and the  
engine ran smoothly. The intake air temperature rose to  
10 70°C where it stabilized. The engine was turned off,  
restarted and continued to run smoothly. By adjusting and  
opening the air intake, the rpm could be increased to over  
4000. By slightly closing the same air intake, the rpm  
could be reduced to 1500. At both ranges of rpm, the  
15 engine ran smoothly and was turned off and restarted  
without difficulty and continued to run smoothly.

The rpm of an engine using the method and fuel of the  
present invention may be regulated by regulating the  
amount of air flow into the combustion chamber. In a  
20 convention gasoline powered engine, the engine rpm is  
regulated by regulating the amount of gasoline that is  
introduced into the combustion chambers.

Gaseous fuels such as methane, ethane, butane or  
natural gas and the like could be liquified and  
25 substituted for ethanol and methanol used in the present  
invention.

The present invention could also be used in jet  
engines, which is another form of internal combustion  
engine.

30 While the embodiment of the invention chosen herein  
for purposes of the disclosure is at present considered  
to be preferred, it is to be understood that this  
invention is intended to cover all changes and  
modifications of all embodiments which fall within the  
35 spirit and scope of the invention.

1     WHAT IS CLAIMED IS:

5           1.     A novel aqueous fuel for an internal combustion engine, said fuel comprising water from about 20 per cent to about 60 per cent by volume of the total volume of said fuel, and a carbonaceous fuel selected from the class consisting of ethanol, methanol, gasoline, diesel fuel or mixtures thereof.

10           2.     The novel aqueous fuel as set forth in claim 1, said fuel comprising water from about 20 per cent to about 50 per cent by volume of the total volume of said fuel.

15           3.     The novel aqueous fuel as set forth in claims 1 or 2 wherein said carbonaceous fuel is selected from the class consisting of ethanol, methanol or mixtures thereof.

20           4.     The novel aqueous fuel as set forth in claims 1 or 2 wherein said carbonaceous fuel is selected from the class consisting of ethanol, gasoline or mixtures thereof.

25           5.     The novel aqueous fuel as set forth in claims 1 or 2 wherein said carbonaceous fuel is ethanol.

30           6.     A method for combusting an aqueous fuel in an internal combustion engine to produce approximately as much power as the same volume of gasoline, said internal combustion engine being capable of producing a range of engine revolutions per minute (rpm) and having one or more combustion chambers and a carburetor or a fuel injection system for mixing said fuel and air and introducing said mixture into said combustion chamber or chambers, said  
35     method comprising:



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1           preheating said air for combustion and  
introducing said preheated air into said carburetor or  
fuel injection system,

5           introducing said aqueous fuel into said  
carburetor or fuel injection system to mix with said  
combustion air, said fuel comprising water from about 20  
per cent to about 60 per cent by volume of the total  
volume of said fuel, and a carbonaceous fuel selected from  
the group consisting of ethanol, methanol, gasoline,  
10       diesel fuel or mixtures thereof, and

15           introducing and combusting said aqueous fuel and  
combustion air in said combustion chamber or chambers in  
the presence of a hydrogen-producing catalyst to operate  
said engine.

15       7. The method as set forth in claim 6 wherein said  
fuel comprises water from about 20 per cent to about 50  
per cent by volume of the total volume of said fuel.

20       8. The method as set forth in claim 6 or 7 wherein  
said carbonaceous fuel is selected from the group  
consisting of gasoline, ethanol, or mixtures thereof.

25       9. The method as set forth in claim 6 or 7 wherein  
said carbonaceous fuel is selected from the class  
consisting of ethanol, methanol or mixtures thereof.

30       10. The method as set forth in claims 6 or 7 wherein  
said carbonaceous fuel is ethanol.

35       11. The method as set forth in claims 6 or 7 wherein  
said combustion air is initially heated by a heater and  
then heated by heat from hot exhaust gases from said  
engine after the engine is operating.

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1           12. The method as set forth in claims 6 or 7 wherein  
said catalyst is selected from the class consisting of  
platinum, platinum nickel alloy, nobel metals, and other  
5           materials that will produce hydrogen when said combustion  
air and said aqueous fuel are combusted over said  
catalyst.

10           13. The method as set forth in claims 6 or 7 wherein  
said catalyst is platinum.

14. The method as set forth in claims 6 or 7 wherein  
said air is preheated to at least about 350°F to about  
400°F as said air enters said carburetor.

15           15. The method as set for in claims 6 or 7 wherein  
said air is preheated from 122°F to about 158°F as said  
air enters said fuel injection system

20           16. The method as set forth in claims 6 or 7 wherein  
said aqueous fuel is introduced into said carburetor or  
said fuel injection system at ambient temperatures.

25           17. The method as set forth in claims 6 or 7 wherein  
said rpm's are regulated by regulating the air flow into  
the carburetor or fuel injection system.

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## AMENDED CLAIMS

[received by the International Bureau  
on 22 April 1991 (22.04.91);

new claims 18-37 added; other claims unchanged (5 pages)]

1           18. A novel aqueous fuel combustible with air in  
an internal combustion engine, said fuel comprising a  
carbonaceous fuel and water in an amount of from  
greater than 20 percent to about 60 to 70 percent by  
5 volume of the total volume of said fuel.

19. The novel aqueous fuel as set forth in claim  
18 wherein said carbonaceous fuel is selected from the  
class consisting of ethanol, methanol, gasoline, diesel  
10 fuel or mixtures thereof.

20. A method for combusting an aqueous fuel in an  
internal combustion engine having (a) one or more  
combustion chambers, (b) a fuel introduction system for  
receiving and mixing fuel and combustion air and  
15 introducing said fuel and air mixture into said  
combustion chamber or chambers and (c) an electric  
spark producing system for creating a spark in said  
combustion chamber or chambers, said method comprising:

20           introducing combustion air in controlled  
amounts into said fuel introduction system,

          introducing aqueous fuel into said fuel  
introduction system to mix with said combustion air,  
said aqueous fuel comprising water from about 20  
25 percent to about 60 to 70 percent by volume of the  
total volume of said fuel, and a carbonaceous fuel  
selected from the group consisting of ethanol,  
methanol, gasoline, diesel fuel, or mixtures thereof,  
and

30           introducing and combusting said aqueous fuel  
and combustion air in said combustion chamber or  
chambers in the presence of a hydrogen-producing  
catalyst to operate said engine, said combustion being  
initiated by a spark generated in said combustion  
35 chamber or chambers.

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1           21. The method as set forth in claim 20 wherein  
said catalyst is selected from the class consisting of  
nickel, platinum, platinum-nickel alloy, noble metals,  
5 alloys thereof, and other materials that will  
dissociate water molecules to produce hydrogen when  
said combustion air and said aqueous fuel are combusted  
in the presence of said catalyst and an electric spark.

10           22. A method according to claim 20 wherein water  
molecules in the aqueous fuel are dissociated in said  
combustion chamber or chambers to release hydrogen and  
oxygen and wherein said hydrogen is combusted in said  
combustion chamber along with carbonaceous fuel.

15           23. The method as set forth in claim 20 wherein  
the power output of the engine is regulated by  
regulating the flow of air for combustion into the fuel  
introduction system.

20           24. The method as set forth in claim 20 wherein  
said combustion air is initially heated prior to  
induction to the combustion chamber by a heater and  
then heated by heat from hot exhaust gases from said  
engine after the engine is operating.

25           25. The method as set forth in claim 20 wherein  
said fuel introduction system includes a carburetor and  
said air is preheated to at least about 350°F to about  
400°F as said air enters said carburetor.

30           26. The method as set for in claim 20 wherein  
said fuel introduction system includes a fuel injection  
system and said air is preheated to at least 122°F as  
said air enters said fuel injection system

35           27. A method for combusting an aqueous fuel  
comprising a mixture of carbonaceous fuel and water in

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1 an internal combustion engine, said combustion being  
capable of producing approximately at least as much  
engine power as the same volume of said carbonaceous  
fuel would produce in said engine without water and a  
5 range of power output as indicated by a corresponding  
range of engine revolutions per minute (rpm), said  
engine having one or more combustion chambers, an  
electric spark producing system for creating a spark in  
said combustion chamber or chambers, and a fuel  
10 introduction system for (a) receiving and mixing said  
fuel with air for combustion, (b) controlling the  
proportions of fuel and air, and (c) introducing said  
fuel and air mixture into said combustion chamber or  
chambers, said method comprising:

15 introducing aqueous fuel and controlled  
amounts of combustion air to said fuel introduction  
system for mixing therein, said aqueous fuel comprising  
water from about 20 percent to about 70 percent by  
volume of the total volume of said fuel and a liquid or  
20 gaseous carbonaceous fuel,

introducing said mixture of aqueous fuel and  
combustion air into said combustion chamber or chambers  
in the presence of a hydrogen-producing catalyst in  
said combustion chamber or chambers; and

25 combusting said aqueous fuel and air mixture  
to operate said engine, said combustion being initiated  
by a spark generated in said combustion chamber or  
chambers.

30 28. A method according to claim 27 wherein water  
molecules in the aqueous fuel are dissociated in said  
combustion chamber or chambers to release hydrogen and  
oxygen and wherein said hydrogen is combusted in said  
combustion chamber along with carbonaceous fuel.

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29. The method as set forth in claim 27 wherein  
said carbonaceous fuel is selected from the group

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1       consisting of alcohols, gasoline, diesel fuel, and  
mixtures thereof.

5       30. The method as set forth in claim 27 wherein  
said hydrogen producing catalyst is selected from the  
group consisting of nickel, platinum, platinum-nickel,  
noble metals, alloys thereof, and other materials that  
will produce hydrogen when said combustion air and said  
aqueous fuel are combusted in the presence of said  
10       catalyst and an electrically generated spark.

31. The method as set forth in claim 27 wherein  
said combustion air is initially heated by a heater and  
then heated by heat from hot exhaust gases from said  
15       engine after the engine is operating.

32. The method as set forth in claim 27 wherein  
said fuel introduction system comprises a carburetor  
and said air is preheated to at least about 350°F prior  
20       to entry into said carburetor.

33. The method as set for in claim 27 wherein  
said fuel introduction system comprises a fuel  
injection system said air is preheated at least about  
25       122°F prior to entry into said fuel injection system.

34. A fuel mixture for combustion in a combustion  
chamber in an internal combustion engine comprising  
aqueous fuel, gaseous or liquid carbonaceous fuel and  
30       hydrogen, said aqueous fuel comprising water in an  
amount of from 20% to 70% by volume of the total volume  
of said aqueous fuel.

35. A fuel mixture according to claim 34 wherein  
35       said carbonaceous fuel comprises ethanol, methanol,  
gasoline, diesel fuel, or mixtures thereof.

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1           36. A method of operating an internal combustion  
engine in a motor vehicle said internal combustion  
engine being capable of producing a range of power  
output as indicated by a corresponding range of engine  
5    revolutions per minute (rpm) and having one or more  
combustion chambers, an electric spark producing system  
for creating a spark in said combustion chamber or  
chambers, and a fuel introduction system for (a)  
receiving and mixing fuel with air, (b) controlling the  
10   proportions of fuel and air and (c) introducing said  
fuel and air mixture into said combustion chamber or  
chambers, said method comprising:

          introducing combustion air in controlled  
amounts into said fuel introduction system,

15           introducing aqueous fuel into said fuel  
introduction system to mix with said combustion air,  
said aqueous fuel comprising water from about 20  
percent to about 70 percent by volume of the total  
volume of said fuel, and a liquid or gaseous  
20   carbonaceous fuel selected from the group consisting of  
alcohols, gasoline, diesel fuel or mixtures thereof,  
and

          introducing and combusting said aqueous fuel  
and combustion air in said combustion chamber or  
25   chambers in the presence of a hydrogen-producing  
catalyst to operate said engine, said combustion being  
initiated by a spark generated in said combustion  
chamber or chambers.

30           37. A method according to claim 36 wherein water  
molecules in the aqueous fuel are dissociated in said  
combustion chamber or chambers to release hydrogen and  
oxygen and wherein said hydrogen is combusted in said  
combustion chamber along with carbonaceous fuel.

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# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US90/06395

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
INT. CL. (5) F02D 19/00		
U.S. CL.: 123/25R;1A		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
U.S.	123/1A; 25R; 25D 44/52	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT</b> <sup>14</sup>		
Category *	Citation of Document, <sup>16</sup> with indication, where appropriate, of the relevant passages <sup>17</sup>	Relevant to Claim No. <sup>18</sup>
Y	US, A, 4,831,971 23 MAY 1989 (OTT et al)	1-17
Y	US, A, 4,333,739 08 JUNE 1982 (NEVES)	1-17
A	US, A, 4,594,991 17 JUNE 1986 (HARVEY)	1-17
A	US, A, 4,476,817 16 OCTOBER 1984 (LINDBERG)	1-17
A	US, A, 2,460,700 01 FEBRUARY 1949 (LYONS)	1-17
A	US, A, 4,563,982 14 JANUARY 1986 (PISCHINGER)	1-17
<p>* Special categories of cited documents: <sup>15</sup></p> <p>"A" document defining the general state of the art which is not considered to be of particular relevance</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step</p> <p>"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.</p> <p>"&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search *	Date of Mailing of this International Search Report *	
14 DECEMBER 1990	21 FEB 1991	
International Searching Authority *	Signature of Authorized Official <sup>19</sup>	
ISA/US	<p>For E. ROLLINS CROSS <i>Nguyen</i></p> <p>INTERNATIONAL DIVISION</p>	



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